(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 June 2003 (26.06.2003)

PCT

(10) International Publication Number
WO 03/051712 A1

(51) International Patent Classification[7]: B63C 13/00, B60F 3/00

(21) International Application Number: PCT/NZ02/00277

(22) International Filing Date:
17 December 2002 (17.12.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

516154	17 December 2001 (17.12.2001)	NZ
518603	29 April 2002 (29.04.2002)	NZ
520154	12 July 2002 (12.07.2002)	NZ
520297	19 July 2002 (19.07.2002)	NZ
520334	23 July 2002 (23.07.2002)	NZ

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US Not furnished (CIP)
Filed on Not furnished

(71) Applicant *(for all designated States except US)*: **SEALEGS INTERNATIONAL LIMITED** [NZ/NZ]; 1:7 Axis Building, 91 Lower St Georges Bay Road, Parnell, Auckland (NZ).

(72) Inventor; and

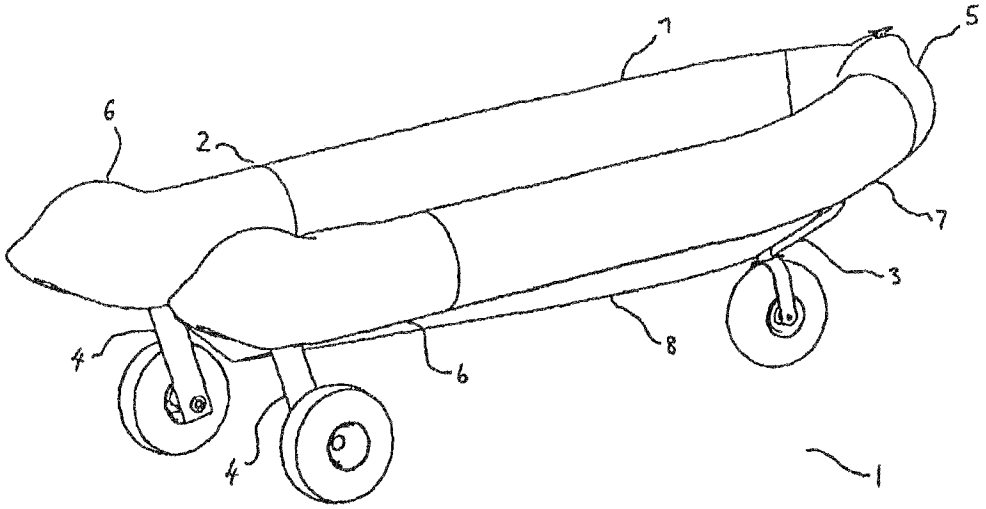
(75) Inventor/Applicant *(for US only)*: **BRYHAM, Maurice, John** [NZ/NZ]; 42 Ocean View Road, Milford, 42 Ocean View Road, Milford, Auckland (NZ).

(74) Agents: **PIPER, James, William**; Pipers, Unicorn House, 300A Richmond Road, Grey Lynn, Auckland 1002 et al. (NZ).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

[Continued on next page]

(54) Title: AMPHIBIOUS VEHICLE



(57) Abstract: An amphibious vehicle (1), in the form of an inflatable boat (2) has a self propelled and steerable retractable under-carriage system, enabling the vehicle to enter and exit the water under its own power. The swing of the wheels and their supporting struts (3) & (4) occurs external to the hull of the vehicle. A steerable nose leg (3) is raised or lowered by an actuator situated inside the boat. Stowage is accomplished within the lines of an inflatable craft by the incorporation of fibreglass fairings (5) & (6) sized to match the main inflated tubes (7). Power is provided to the back wheels (4) via an internal drive train within the legs (4). All terrain balloon type tyres are used to enable the boat to travel over a variety shoreline terrain. A steering system engages with the front wheel when the wheel is in its extended position. Motive power is provided by a separate aircooled motor.

WO 03/051712 A1

Amphibious Vehicle

FIELD OF THE INVENTION

This invention relates to amphibious vehicles and retractable, steerable and motorised wheel and leg assemblies for amphibious vehicles.

BACKGROUND OF THE INVENTION

Users of small to medium sized boats will most likely have encountered the problems associated with launching a boat, or retrieving it after use. Whether the boat is to be beached for one hour to enjoy a picnic on a remote beach, or to be removed from the water for winter storage, the difficulties are similar.

Beaching a boat or jet-ski can present a number of problems. The first is that when there is no jetty or wharf in the area in which the boat is to be landed, then at least one of the occupants of the boat usually needs to get their feet wet. This can be both inconvenient and a discomfort, and can pose further difficulties if the boat only has one occupant.

Quite apart from the problems of approaching a beach or shoreline that does not have a jetty or wharf, there is the basic problem of launching and retrieving boats on pieces of shoreline which do not have a suitable launching ramp.

Even if launching ramps are available, recreational boat users still encounter a number of problems, particularly in urban areas because launching ramp facilities are usually in high demand. These areas are often congested since launching ramps usually only have facilities to allow one or two boats to be launched or retrieved at any one time. Therefore at the beginning and end of weekends or other holidays there may be queues at launching ramp facilities since

the hull, as used in these previous designs, often become unsightly, or entangled with seaweed, or leak excessively, or create an undue maintenance burden.

OBJECT OF THE INVENTION

It is an object of the present invention to provide a useful and appealing multi-terrain retractable undercarriage system and/or motorised undercarriage system and/or a steerable undercarriage system, or to provide an amphibious vehicle including a retractable undercarriage system and/or a motorised undercarriage system and/or a steerable undercarriage system, which will at least go some way toward overcoming the foregoing disadvantages, or which will at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

Accordingly in one aspect the invention may broadly be said to consist in an amphibious vehicle having ground engaging means, moveably mounted relative to the amphibious vehicle and capable of being disposed in an extended position in which the amphibious vehicle may be supported by the ground engaging means when they are in contact with terra-firma, and being capable of being disposed in a retracted position in which the amphibious vehicle may be used on water, wherein the ground engaging means are both deployed and tidily stowed without the need for moveable door or flaps in the surface of the hull of the amphibious vehicle.

Preferably the amphibious vehicle is primarily a waterborne vehicle, for example but not limited to a boat, jet-boat, an inflatable boat, jet-ski, hydrofoil or air boat.

Preferably the ground engaging means consists of at least three wheels.

Preferably the wheels are fitted with rubber tyres.

Preferably the rubber tyres are balloon type rubber tyres.

Preferably the tyres have all-terrain type tread, suited to a range of shoreline terrain.

Preferably, if the amphibious vehicle is an inflatable craft, at least one of the undercarriage assemblies are stowed substantially within the lines of the primary inflated tubes.

Preferably at least one of the moveable mounted undercarriage assemblies are pivotally attached to the structure of the amphibious vehicle.

Preferably support bearings for the undercarriage assembly pivot attachments are positioned in reinforced structure on the hull of the amphibious vehicle and are positioned distal from the primary axis of the amphibious vehicle. This is of most importance in the case of the forward most undercarriage assembly, which may include a single wheel, and the incorporation of bearing supports as far apart as possible on the typically narrower bow section of the vehicle will provide a more stable attachment means.

Preferably the bow end pivot support assembly comprises at least a shaft passing from port to starboard, above the water line, and supported in reinforced structure in the hull of the amphibious vehicle, at both the port and starboard sides.

Preferably the shaft passing from port to starboard further comprises means to engage with an actuator.

Optionally the shaft passing from port to starboard comprises a shaft assembly made up of more than one shaft.

Preferably the forward leg comprises two rigid elongate members, one end of each pivotally supported from each side of the vehicle, and the other end of each member rigidly connected to each other, to form a substantially "V" shape.

More preferably the two rigid elongate members forming the forward leg are shaped to fit neatly about the bow of the vehicle when the leg is in the stowed position.

Preferably the two rigid elongate members are each rigidly attached to opposing ends of the shaft passing from port to starboard through the hull of the amphibious vehicle

Optionally the two rigid elongate members are not attached to a transverse shaft, but simply pivotally attached to the hull, or a fitting thereon.

Preferably steerable leg assemblies are mechanically locked or clamped adjacent to the mating point of the steering mechanism, to ensure a stable connection of the steering system is maintained.

Optionally at least one leg assembly, at a location distal from the moveable attachment to the hull structure, also comprises a member shaped to mate with the lower surface of the hull, at the location where the leg contacts the hull, and of sufficient area to spread and transfer loads between the hull and the ground engagement means during land supported operations, without causing damage to the hull structure.

Optionally the hull is formed having at least one recess into which at least one hook, moveably attached to at least one leg assembly, can be engaged to restrain the leg in at least one direction.

Optionally at least one movably attached hook has powered means to move the hook and engage it with a recess in the hull.

Optionally features are provided in the leg assemblies and hull to manually install downlock pins or clamps to further mechanically lock the leg assemblies in the extended or retracted positions if required.

In a preferred form, the invention further includes a system of retractable leg assemblies for an amphibious vehicle, wherein powered mechanisms are employed to either extend or retract the leg assemblies, or both extend and retract the leg assemblies.

Preferably the powered mechanisms can fully extend or retract the leg assemblies when the amphibious vehicle is supported on water.

Preferably the powered mechanisms can fully extend the legs, and lift the vehicle if necessary, even when the amphibious vehicle is situated on dry land.

Preferably the powered mechanisms are in the form of an hydraulic system, comprising for example but not limited to a pump, valves and actuators.

Preferably a hydraulic actuator in the bow of the amphibious vehicle acts via levers to rotate the transverse shaft located between the two rigid elongate members forming the leg of the forward undercarriage assembly, if that configuration of undercarriage is chosen.

Preferably the means to self-align the ground engaging means is a spring mechanism, arranged to return the ground engaging means to the desired alignment when no external load is applied, i.e. during the extension or retraction phases.

Optionally a single guide or a system of guides causes the ground engaging means to align as required.

Preferably a connection is made between any steerable ground engaging means and the steering system at or near the point of full extension of the corresponding undercarriage assembly or assemblies, and similarly the connection is broken at or near the beginning of the retraction phase of the corresponding undercarriage assembly or assemblies.

Preferably a steering driven member on each steerable undercarriage assembly, connected to or able to influence the orientation of the ground engaging means supported thereon, mates with a steering drive member positioned within the hull of the amphibious vehicle, which is in turn influenced by a steering system, and the mating of the two members being such as to allow rotational forces to be transmitted from one to the other.

Preferably a sealing method is incorporated between the steering drive member, and the surrounding fixed structure of the hull, to prevent or significantly reduce water ingress.

Preferably the steering drive member is set within a recess in the hull, to cause minimal interruption to the streamlined shape of the hull.

Preferably the mating portions of either one or both of the steering driven members and the steering drive members incorporate(s) self-aligning features, such that angular mis-matches between the members will be resolved as they mate.

Optionally a steering actuator forms part of at least one retractable leg assembly.

Optionally the steering actuator that forms part of at least one retractable leg assembly is an electrically powered rotary actuator.

As a further option the steering actuator that forms part of at least one retractable leg assembly is an hydraulic actuator.

by the engine, or in the form of electrical energy supplied from an alternator or generator driven by the engine.

Optionally batteries may be incorporated to supply electrical energy for the production of motive power.

Optionally the batteries may be charged from a generator driven by an internal combustion engine.

As a further option, electrical power from a ground based system may be used during operations close to or on-shore.

Preferably a clutch and torque converter or gearing system, or combination of these is employed to control and vary the torque produced by the engine before it is transmitted to the driven ground engaging means.

Preferably any two ground engaging means positioned on opposite sides of an amphibious vehicle are driven from a common transverse shaft.

Preferably the common transverse shaft is driven via a differential gearbox.

Optionally the differential gearbox is a limited slip differential gearbox, or includes a differential lock.

Preferably the portion of the power drive train that travels down each leg to a ground engaging means is housed within the leg.

More preferably the drive train within each leg is encased to substantially prevent water entering the drive chain, and the aperture where the final stub axle passes through the encasement contains a rotary seal.

Preferably the portion of the drive train that travels down any legs uses chains and sprockets.

Optionally the portion of the drive train that travels down any legs uses pulleys and belts.

As a further option, the portion of the drive train that travels down any legs uses drive shafts and bevel gearboxes.

Preferably one or more of the ground engaging means can be retarded or stopped completely by a braking mechanism or mechanisms.

Preferably the braking mechanism or mechanisms incorporate friction pads.

Preferably the braking mechanism or mechanisms are situated remote from the wheels to reduce the possibility of water ingress.

Optionally the braking mechanisms are situated adjacent to the wheels and are protected from water ingress.

Optionally wet braking mechanisms are used.

Optionally separate braking controls allow for differential braking between port and starboard brake assemblies to assist with directional control.

In a preferred form, the invention further includes an engine cooling system for a marine engine, the system including an air cooled re-circulating cooling means adapted to cool the engine coolant fluid.

Preferably the system further includes a reservoir of coolant fluid.

Preferably the system includes fan means, such as an electric or motor driven fan to pass air over an air cooled heat exchanger means.

In a preferred form, the system further includes one or more valves provided within the engine coolant liquid lines, the one or more valves being operative to bypass the water cooled engine coolant flow and divert the coolant flow through the air cooled re-circulating cooling means.

In a preferred form, the invention further includes a silencer for an outboard motor, the silencer including a body adapted to be located in or about the hub of a propeller, and the body having one or more baffle openings or passageways therein for passage of exhaust gases therethrough, and attachment means being provided to attach the silencer to the propeller.

the ground engagement means on a ground surface, and each ground engagement means capable of being disposed in a retracted position in which the amphibious vehicle may be used in water without substantial hydrodynamic interference from the ground engagement means, and wherein a forward leg assembly, comprises a first rigid elongate member, one end of the first member being pivotally attached to a point on the hull, and the other end being connected to a ground engagement means supported thereon, so that the ground engagement means can be moved between the retracted location adjacent to the bow of the vehicle and the extended location, in an arc, without passing through any of the primary structure of the hull of the amphibious vehicle.

Preferably the forward leg assembly includes a second substantially rigid elongate member, one end of each member being pivotally attached to points on the hull distal from each other, and the other end of each member being connected about the ground engagement means supported thereon, the leg assembly forming a substantially "V" shape, so that the ground engagement means can be moved between the retracted location adjacent to the bow of the vehicle and the extended location in an arc, without passing through any of the primary structure of the hull of the amphibious vehicle.

Preferably at least one pivotally attached leg has engagement means, at a location distal from the leg's pivot attachment point, so that the leg can be engaged with, and be restrained in at least one direction by, a connection to the hull of the amphibious vehicle.

Preferably at least one of the legs, at a location distal from the moveable attachment to the hull structure, also comprises a member shaped to mate with the lower surface of the hull, at the location where the leg contacts the hull, and of sufficient area to spread and transfer loads between the hull and the ground engagement means during land supported operations, without causing damage to the hull structure.

Preferably an actuator mounted and acting within the exterior skin of the hull, operates to move at least one of the legs from the retracted position to the extended position and/or in the opposite direction.

Preferably at least one of the ground engagement means is steerable.

Figure 8 leg assembly, uplock mechanism, ready to engage.

Figure 8A leg assembly, uplock mechanism, engaged.

Figure 8B partially cutaway view of the leg assembly, downlock mechanism.

Figure 8C cross section of boat hull showing alternative downlock arrangement.

Figure 9 partially cutaway view of the leg assembly and the connection with the steering system.

Figure 9A steering system, mating adapter.

Figure 10 leg assembly, with integrated steering actuator.

Figure 11 "7" shaped leg assembly.

Figure 12 partially cutaway view of the "7" shaped leg assembly in extended position.

Figure 13 partially cutaway view of the "7" shaped leg assembly in retracted position.

Figure 14 straight leg mounted on vertical bulkhead.

Figure 15 vertical bulkhead attachment points.

Figure 16 x-ray view of the stowage of forward leg and wheel assembly within the lines of the inflatable tubes.

Figure 17 x-ray view of the stowage of aft leg and wheel assemblies within the lines of the inflatable tubes.

Figure 18 tyre forming bumper

Figure 19 schematic, motive power using separate stationary engine.

Figure 20 schematic, marine engine modified with transmission providing "Power Take-Off" shaft.

The invention also provides an amphibious vehicle of many forms as detailed below depending in the design or configuration of the undercarriage, and how it is stowed, the steering and braking system used, and the motive power and drive train employed.

A first preferred embodiment, see paragraph **1.0** below, is an inflatable craft, with an having a three wheeled retractable undercarriage system, having a steerable front leg assembly, and two powered aft leg assemblies, the ground engagement means being powered via drive trains within the leg assemblies.

A second preferred embodiment, see paragraph **2.0** below, is a jet-boat having a similar undercarriage, steering and braking system, and drive train, as in the first preferred embodiment, but where the motive power is provided from a modified main engine and transmission, and where the wheels and legs are stowed within adaptations to the rigid hull.

A third preferred embodiment, see paragraph **3.0** below, is a rigid hulled craft, with an outboard motor as commonly used as pleasure craft, having similar undercarriage, steering and braking system, and motive power and drive train, as in the first preferred embodiment, but where the stowage of the wheels and legs is similar to the second preferred embodiment.

A fourth preferred embodiment, see paragraph **4.0** below, is an inflatable or rigid hull having similar undercarriage, steering and braking systems, as in the first preferred embodiment, and having stowage of the wheels and legs similar to the first and third preferred embodiments, but having the motive power provided by a modified outboard motor, and optionally a modified drive train wherein a flexible drive shaft is used to transfer power from the motor into the drive train.

A fifth preferred embodiment, see paragraph **5.0** below, is an inboard powered craft, having a shaft driven propeller, or a stern-drive unit, and having a similar undercarriage, steering and braking system, and power train, as used in the first preferred embodiment, but having stowage of wheels and legs, and motive power provided as in the second preferred embodiment.

1.0 FIRST EXAMPLE – AN INFLATABLE CRAFT

Figure 1 shows a first preferred embodiment of the amphibious vehicle 1, comprising an inflatable craft 2, fitted with a single nose undercarriage assembly 3 and two aft undercarriage

position to the extended position. The transverse shaft 21 is supported within bearings in the hull, bearing on surfaces 23. Slots 22 in the bearing support assembly 20 are used by the downlock mechanism shown below.

Figure 5 shows the leg assembly 19 in the extended position, that is in the configuration for navigating land surfaces. In this configuration the gear assembly is supported in three locations, being the two bearing supports 25, one at each end of the transverse shaft 21, and the point where the bearing support assembly engages with the hull 29.

Figure 6 shows the leg assembly 19 in the retracted position, that is in the configuration for navigating water surfaces. In this configuration the gear assembly is supported in three locations, being the two bearing supports 25, one at each end of the transverse shaft 21, and the point where the uplock mechanism 30 captures a lug on the fork assembly 17.

It can be seen from both **Figures 5 and 6** that the load from the nose leg 19 is spread over three relatively widely spaced points, thereby necessitating minimal stiffening to the hull 8 to absorb the loads from the nose leg 19 during navigation over land, and the loads from supporting the weight of the nose leg assembly during navigation over rough water surfaces.

It can also be seen from **Figures 5 and 6** that this nose leg arrangement, and the path of travel, results in relatively little disruption to the usual lines of the hull. The main disruption occurs where the leg contacts the hull in the down position and engages with the optional steering mechanism, the other disruption being the optional recess in the hull above the water line where the wheel is faired. In each case the disruption to the hull is significantly less than comparible systems using doors or flaps to allow undercarriage components to pass through the hull, and requiring sealing afterwards. Significant advantages result from this system with regard to lower maintenance, but also less operating difficulties, for example less mechanisms to tangle with weed, or doors and openings to leak, or mis-fair causing drag problems

Figure 7 shows the position and the nature of one form of the mechanism used to drive the nose leg assembly between the extended, and the stowed, positions. An actuator 26 acts via levers 27 to rotate shaft 21, causing the movement of the leg assembly 19. It can be seen that the actuator 26 acts, and is located, within the drier environment inside of the hull 8 of the craft. This is highly advantageous in that the most complex mechanisms are not exposed to salt water.

The fact that the steering disengages as soon as the nose leg leaves the down and locked position when being retracted is of great benefit as it allows the wheel to be stowed in a narrow recess with no chance of inadvertent steering inputs causing conflict.

Since there is only a mechanical link to the steered wheel when it is in the down and locked position it is possible to provide a simple link into the crafts marine steering system, which needs no further disconnection means for use of the craft on water. The steering fitting 33, whether it be manually operated or power assisted, is supported in bearings and passes through a water seal (not shown) adjacent to the keel of the hull.

The synergy with the crafts marine steering system further reduces complexity, and the need for additional controls, and keeps the craft relatively simple to operate.

Figure 10 shows an optional steering system in which a powered actuator 50 is mounted on the leg 19. The power source and steering control information (not shown) can be supplied in the form of electrical, magnetic, hydraulic or pneumatic means and can travel down the leg assembly 19, or be supplied via a socket in the hull of the craft.

1.3 Aft Leg Assembly

The preferred configuration for the aft leg assembly was found to be a "7" shaped leg 60, as shown in **figure 11**. A single rigid leg reduces complexity in that there are no folding mechanisms and associated extra pivots and bearings. Similarly a leg which maintains a single shape provides a simpler path down which to pass a drive train, as detailed below.

The "7" shaped legs allow a simple and compact structural attachment to the crafts hull. **Figure 12** shows a simple three point attachment system, positioned on a horizontal platform 61 forming part of the hull 8 of the craft. Two pivot points 62 (one shown, the other hidden) support one end of the leg, allowing it to pivot up and down, but restraining side loads. The third point, a lug 63 supports an hydraulic actuator 64 which is further connected to the leg 60 via pin 65 to raise and lower the leg. **Figure 12** shows the leg 60 in the extended position, for land navigation.

Figure 13 shows the leg 60 in the retracted position for marine navigation.

1.5 Motive power

The motive power to drive the ground transport means may be provided by number of methods. A simple solution was found to be the use of a separate stationary engine suited to air cooling, but alternatives are to adapt the crafts own marine engine to also provide power for ground operations. Additionally stored electrical power, or power from a generator, or even electrical power from a ground based system could be used for short distances. Some of these options are described more fully as follows;

Figure 19 is a schematic showing the use of a separate stationary engine 80. A relatively small internal combustion engine 80 is mounted in a convenient location within the craft, and via a suitable drive train, provides torque to the wheels. The drive train includes any of the following, a clutch 81, a torque converter 82, a multiple ratio gearbox 83, a differential gearbox 84. The completion of the drive train to the wheels 16 is detailed below, see Figure 26.

Figure 20 shows an alternative configuration, in which the crafts marine engine 85, which is normally used to drive the propeller 113, is also used as the motive power source for the ground engagement means16. and a power take-off 87 driven from the transmission 86 is used. The power take-off shaft can be coupled to a transmission assembly, for example a multiple ratio gearbox 83, and/or a differential gearbox 84. The completion of the drive train to the ground engagement means 16 is detailed below, see Figure 26.

Figure 21 shows the marine engine 85, including a separate re-circulating liquid cooling system 90. When the craft is operated on dry land, the liquid cooling circuit is switched using valves 93 to draw liquid from the re-circulating cooling system 90, instead of drawing the liquid from the water in which the craft is operating. The re-circulating system 90 can include either or both of the following; an air cooled radiator 91, and a reservoir of coolant 92. Similarly the marine engine 85, if it has an under water exhaust silencing system is adapted to contain a valve which can redirect the exhaust gases to a muffler assembly, when the craft is not being operated in water.

Figure 26 A drive train is situated within the leg assembly 4, sealed from contact with water. The leg 60 is shown cut-away to expose the internal drive train. In practice the leg 60 fully encloses the drive train and protects it from the water. Furthermore, the leg 60 has a hydrodynamically efficient cross section. The drive train comprises at least chains (not shown) and sprockets 110, however a number of other methods could be used, for example but not limited to, belts and pulleys, drive shafts and bevel gear boxes, etc.

1.7 Braking System

Figure 27 shows a braking system employing a disk brake assembly 112 on a transverse drive shaft 114 which is used to provide motive power to the driven wheels. An advantage of this location for the brake assemblies is that it keeps the braking mechanisms substantially dry. As further examples, alternative locations for the brake assembly or assemblies 112, would be directly adjacent to each braked ground engagement means, or adjacent to the top of the leg supporting each braked ground engagement means.

The option of situating the brake assemblies 112 adjacent to the ground engagement means is advantageous if it is necessary to gain road worthiness acceptance for the vehicle.

Two further options are available to protect the brakes during operations into water, one being to house the brakes in a sealed and dry enclosure, the other being to employ sealed, wet brake assemblies (not shown).

To assist with or to provide steering, differential braking between ground engagement means on separate sides of the craft is used.

Also shown in this figure is an example of a reduction gearbox assembly 83, as referred to in earlier figures, and a drive shaft 115 transferring torque from a motor.

2.0 SECOND EXAMPLE – JET BOAT

2.1 Nose gear – similar to that described in **Example 1** above, refer to paragraph 1.1.

2.2 Steering - similar to that described in **Example 1** above, refer to paragraph 1.2

4.2 Steering - similar to that described in **Example 1** above, refer to paragraph 1.2

4.3 Aft gear – similar to that described in **Example 1** above, refer to paragraph 1.3

4.4 Stowage of legs and wheels - similar to that described in **Example 1 or 2** above, refer to paragraph 1.1 and 2.1, depending whether the craft has an inflatable or rigid hull.

4.5 Motive power – uses a modified version of the outboard motor providing a "Power Take-Off' in the form of either a drive shaft , hydraulic pump, higher output electrical generator.

4.6 Drive train - similar to that described in **Example 1** above, refer to paragraph 1.6, except for the additional option of a flexible driveshaft from motor introducing torque to the drive train.

4.7 Braking - similar to that described in **Example 1** above, refer to paragraph 1.7.

5.0 FIFTH EXAMPLE – PROPELLER CRAFT POWERED BY INBOARD ENGINE

This example relates to boats powered by an inboard engine, typically driving a propeller via a long shaft or via a stern drive unit.

5.1 Nose gear – similar to that described in **Example 1** above, refer to paragraph 1.1.

5.2 Steering - similar to that described in **Example 1** above, refer to paragraph 1.2

5.3 Aft gear – similar to that described in **Example 1** above, refer to paragraph 1.3

5.4 Stowage of legs and wheels - similar to that described in **Example 2** above, refer to paragraph 2.4.

5.5 Motive power – similar to that described in **Example 2** above, refer to paragraph 2.5.

5.6 Drive train – similar to that described in **Example 1** above, refer to paragraph 1.6

5.7 Braking - similar to that described in **Example 1** above, refer to paragraph 1.7

Finally, it will be appreciated that various other alterations or modifications may be made to the foregoing without departing from the scope of this invention.

CLAIMS:

1. An amphibious vehicle having a boat hull which has at least three ground engagement means connected thereto, each ground engagement means capable of being disposed in an extended position in which the boat hull may be supported by the ground engagement means on a ground surface, and each ground engagement means capable of being disposed in a retracted position in which the amphibious vehicle may be used in water without substantial hydrodynamic interference from the ground engagement means, and wherein a forward leg assembly, comprises a first rigid elongate member, one end of the first member being pivotally attached to a point on the hull, and the other end being connected to a ground engagement means supported thereon, so that the ground engagement means can be moved between the retracted location adjacent to the bow of the vehicle and the extended location, in an arc, without passing through any of the primary structure of the hull of the amphibious vehicle.

2. An amphibious vehicle as claimed in claim 1, wherein the forward leg assembly includes a second substantially rigid elongate member, one end of each member being pivotally attached to points on the hull distal from each other, and the other end of each member being connected about the ground engagement means supported thereon, the leg assembly forming a substantially "V" shape, so that the ground engagement means can be moved between the retracted location adjacent to the bow of the vehicle and the extended location in an arc, without passing through any of the primary structure of the hull of the amphibious vehicle.

3. An amphibious vehicle as claimed in claim 1 or 2, wherein at least one pivotally attached leg has engagement means, at a location distal from the leg's pivot attachment point, so that the leg can be engaged with, and be restrained in at least one direction by, a connection to the hull of the amphibious vehicle.

4. An amphibious vehicle as claimed in claim 1or 2, wherein at least one of the legs, at a location distal from the moveable attachment to the hull structure, also comprises a member shaped to mate with the lower surface of the hull, at the location where the leg contacts the hull, and of sufficient area to spread and transfer loads between the hull and

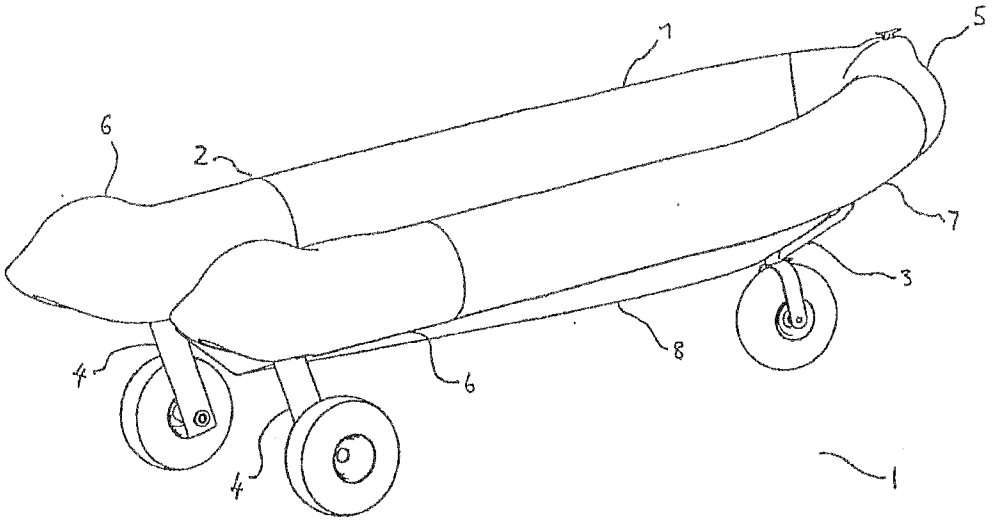


Figure 1

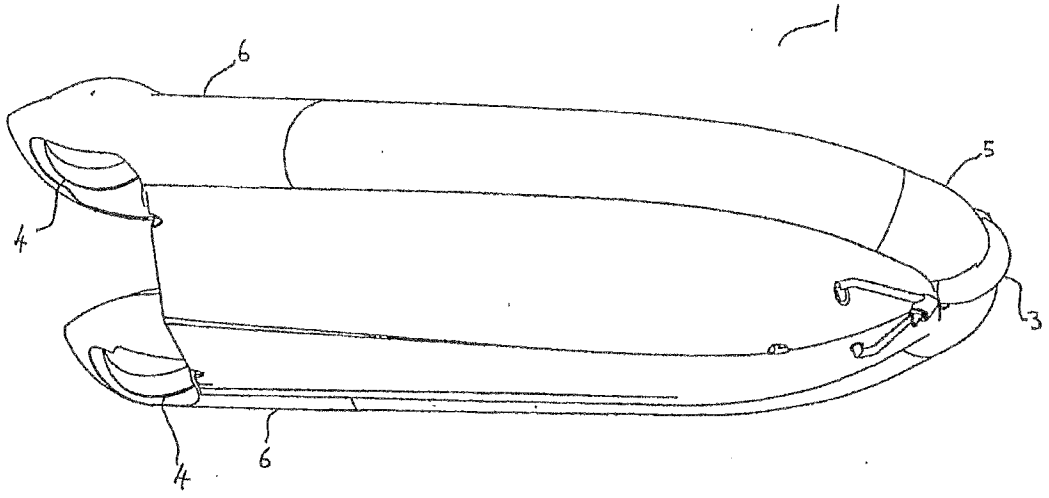


Figure 2

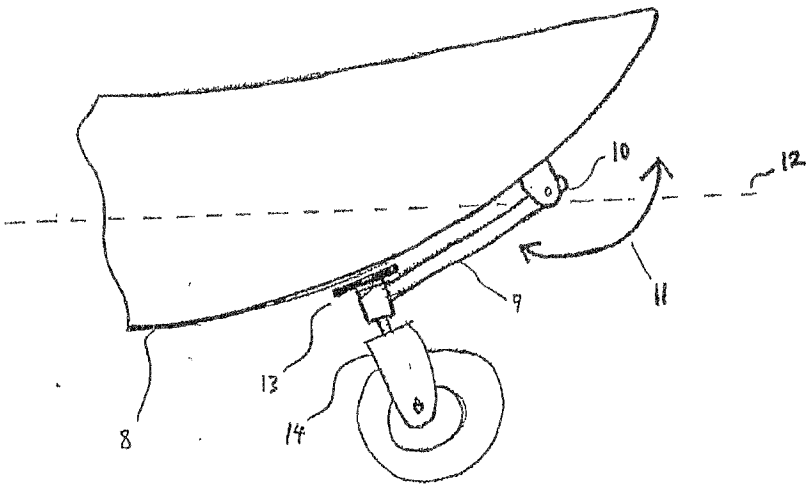


FIGURE 3

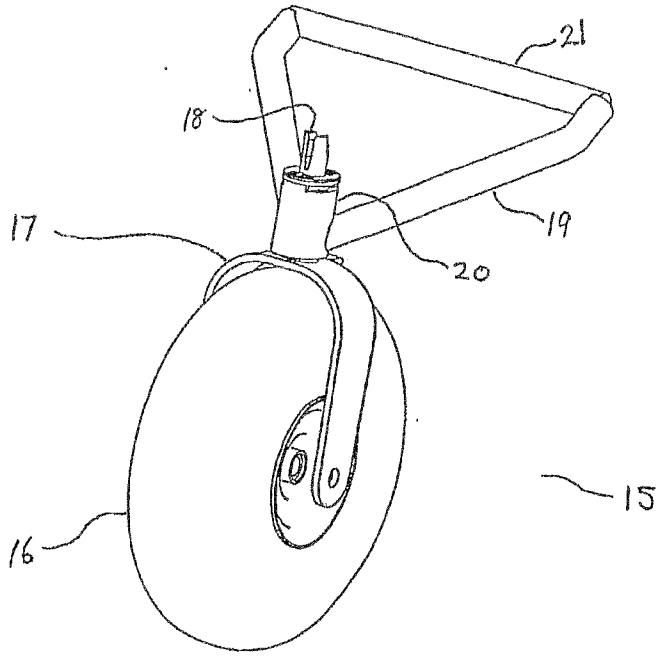


Figure 3A

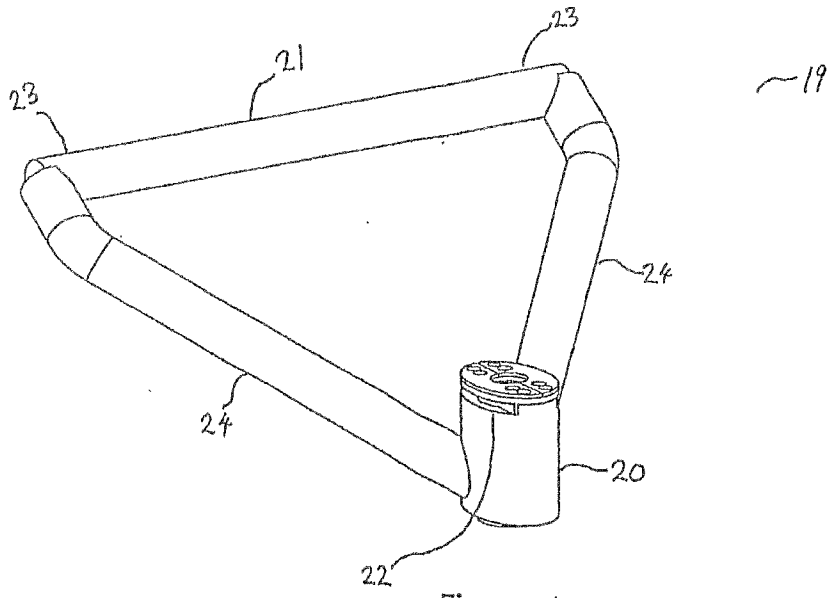


Figure 4

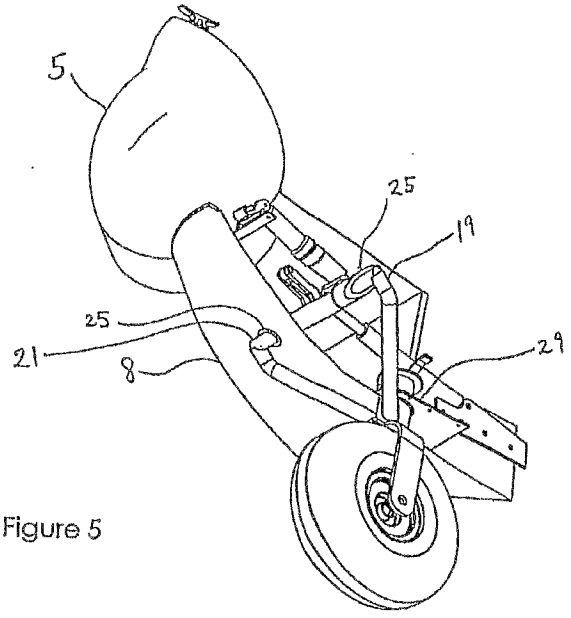


Figure 5

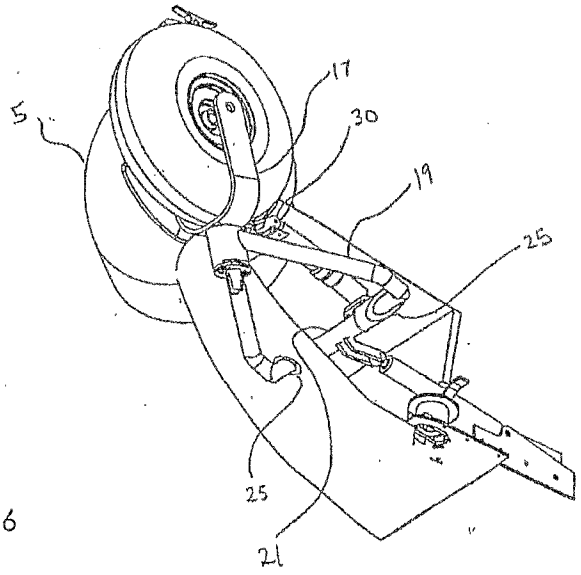


Figure 6

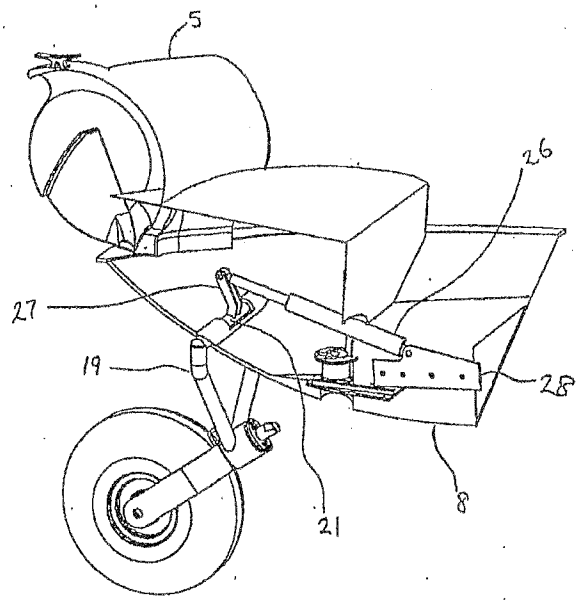


Figure 7

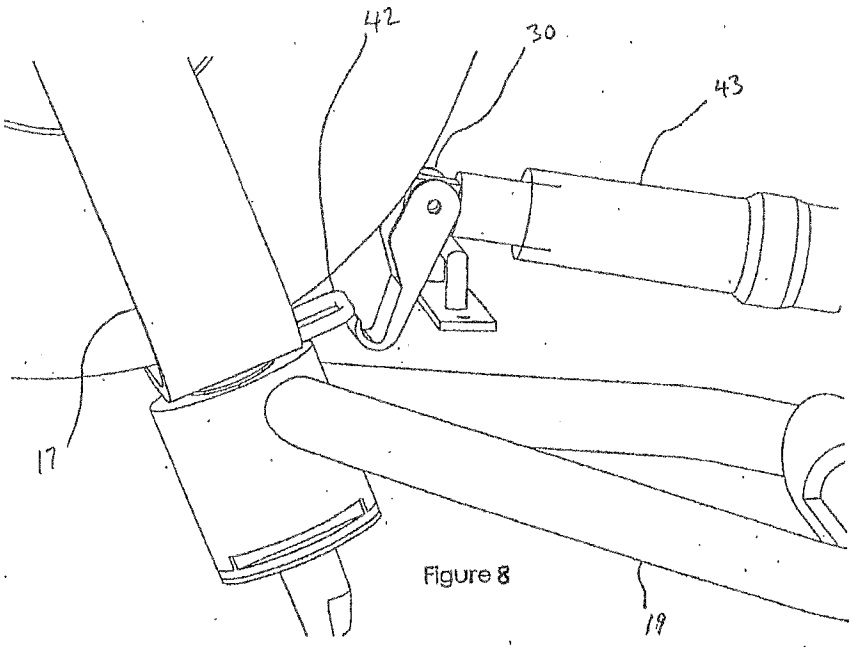


Figure 8

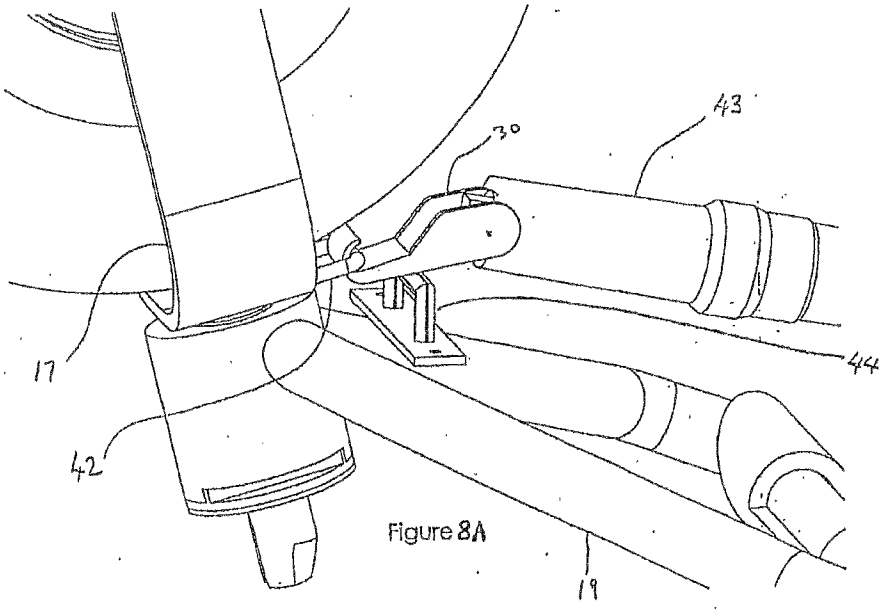


Figure 8A

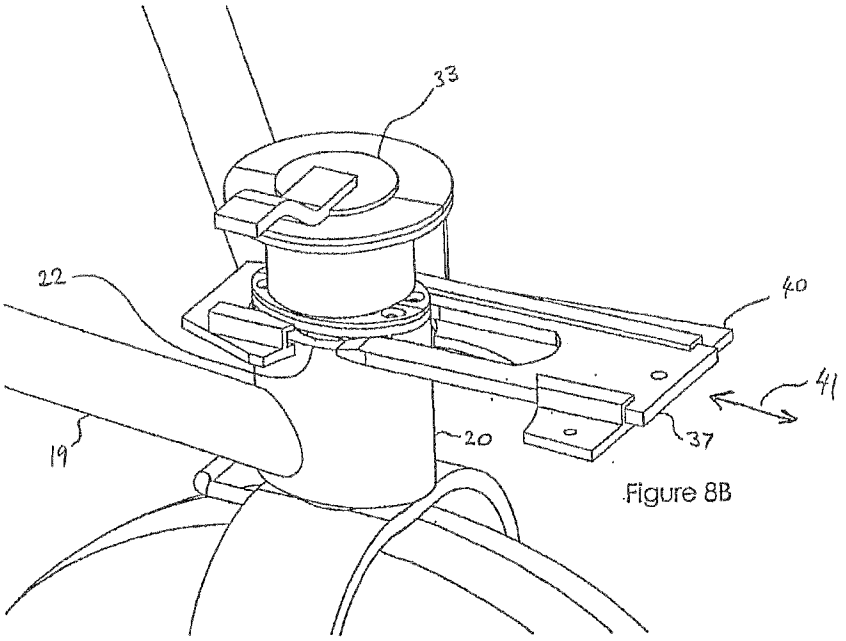


Figure 8B

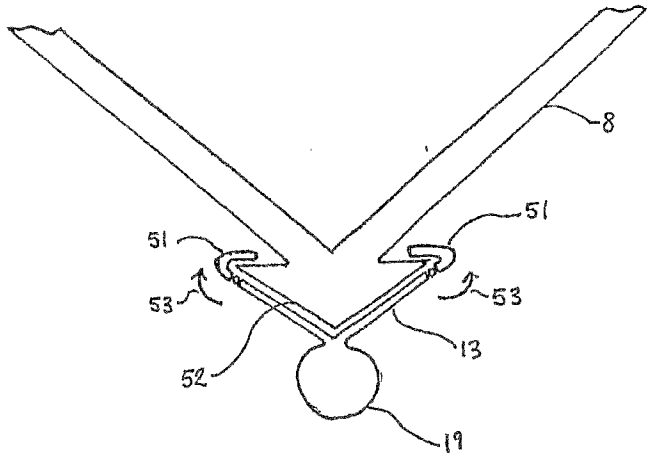


FIGURE 8C

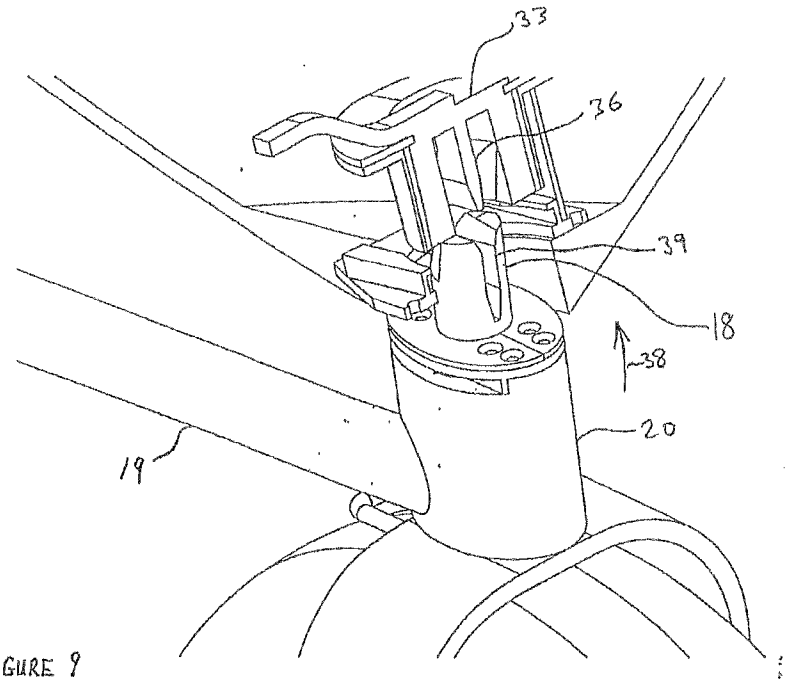


FIGURE 9

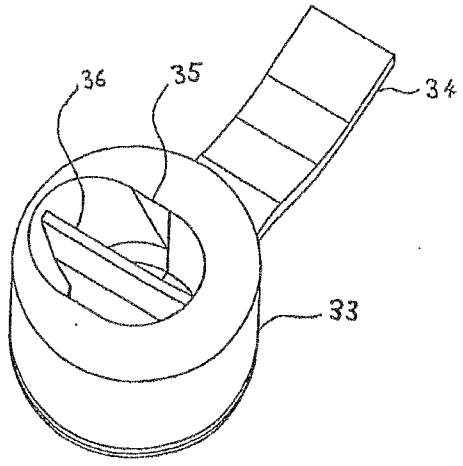


Figure 9A

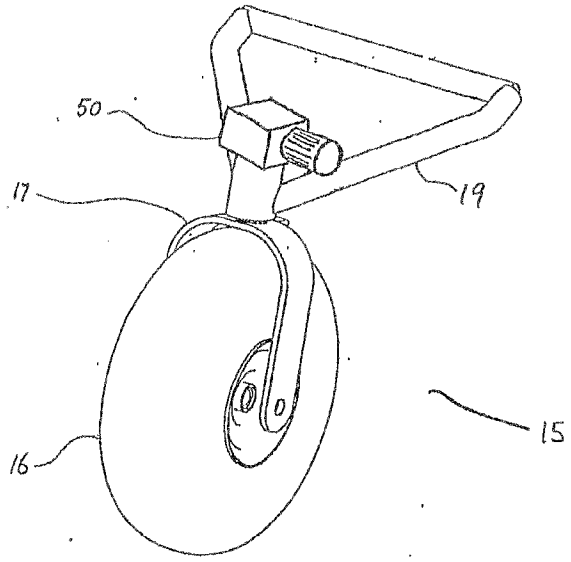


Figure 10

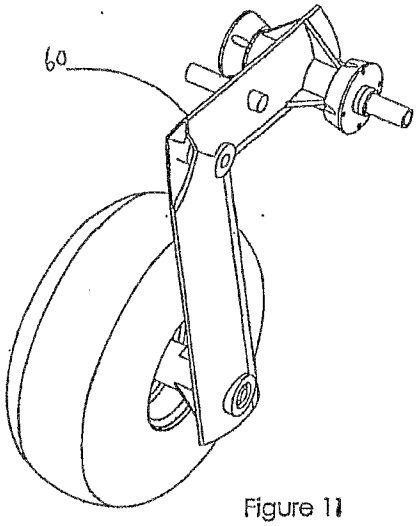


Figure 11

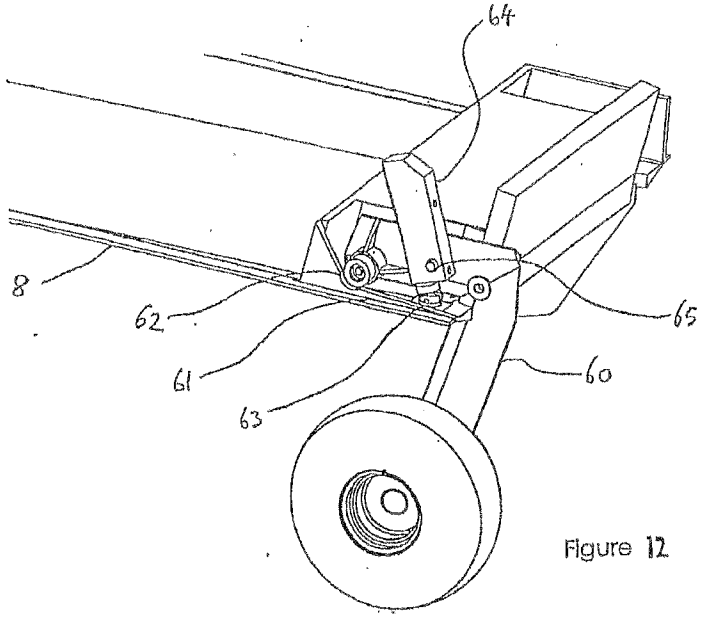


Figure 12

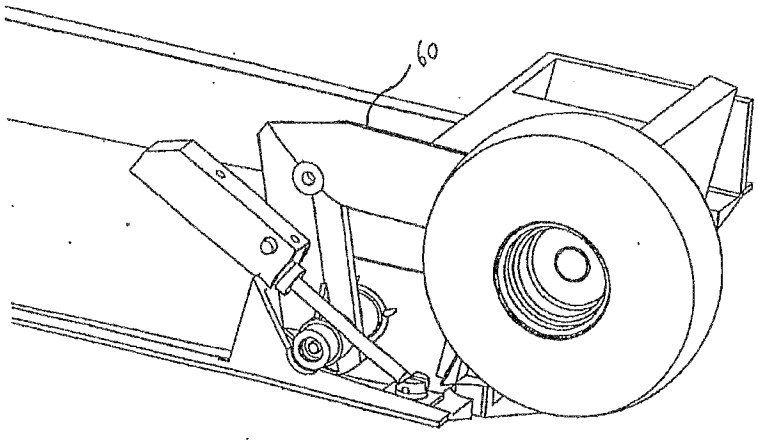


Figure 13

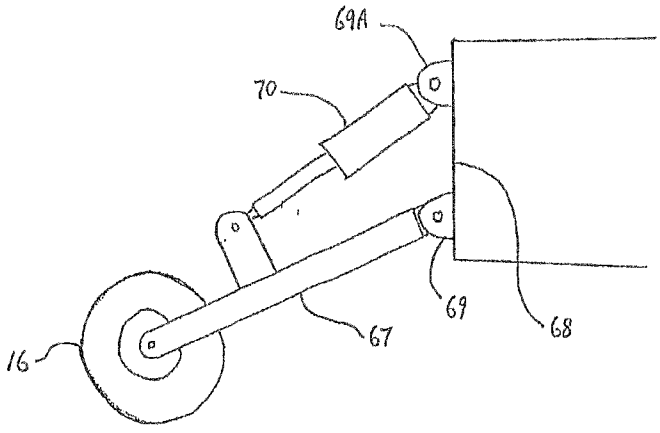


FIGURE 14

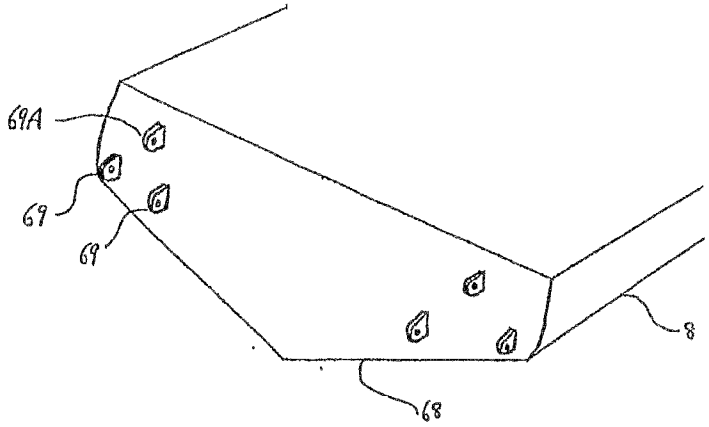


FIGURE 15

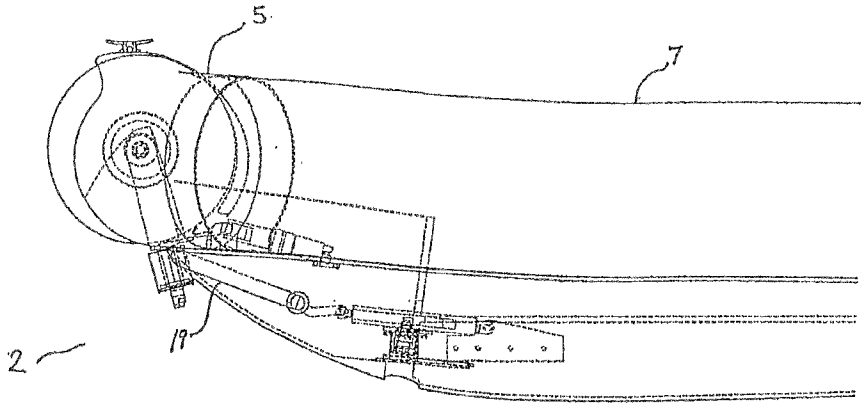


Figure 16

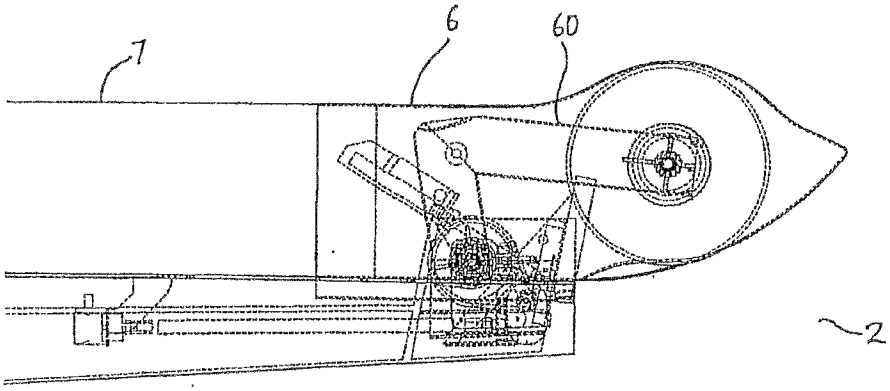


Figure 17

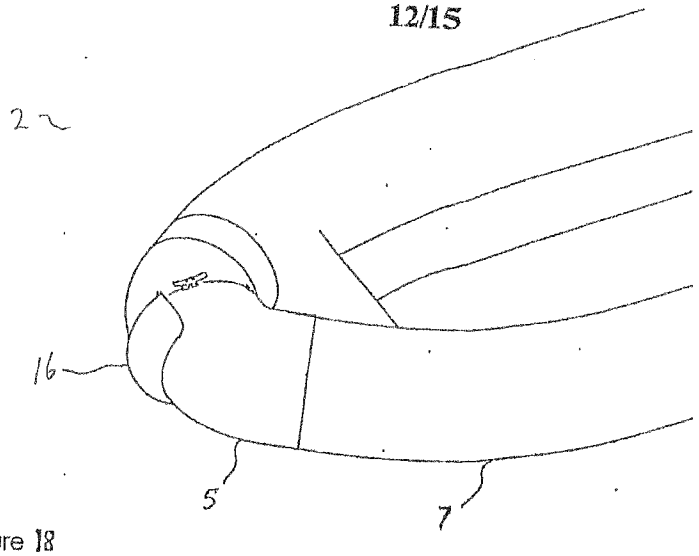


Figure 18

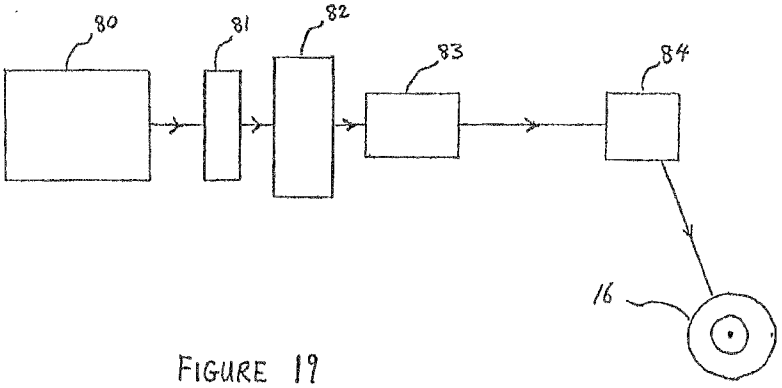


FIGURE 19

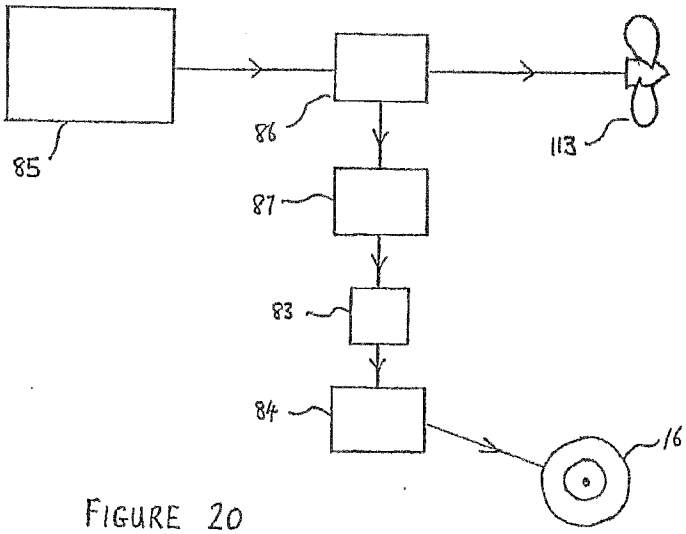


FIGURE 20

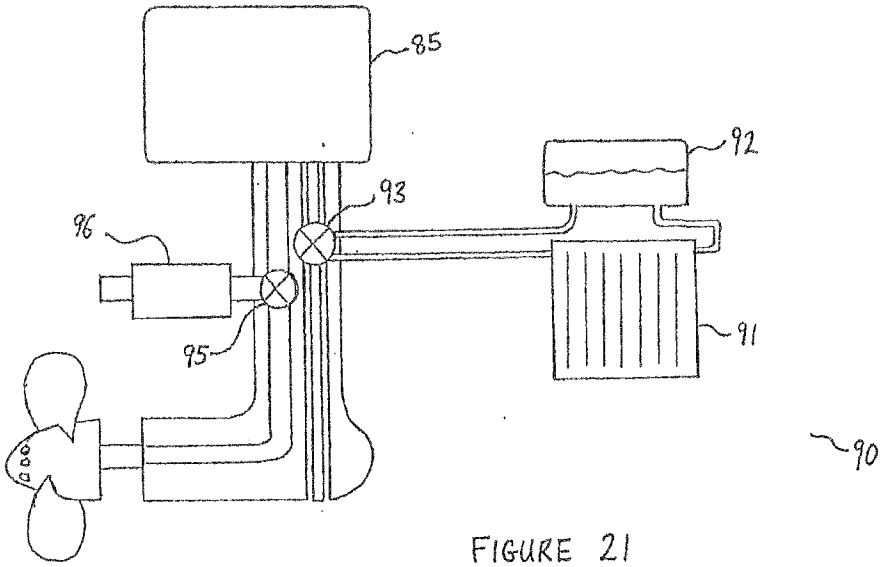


FIGURE 21

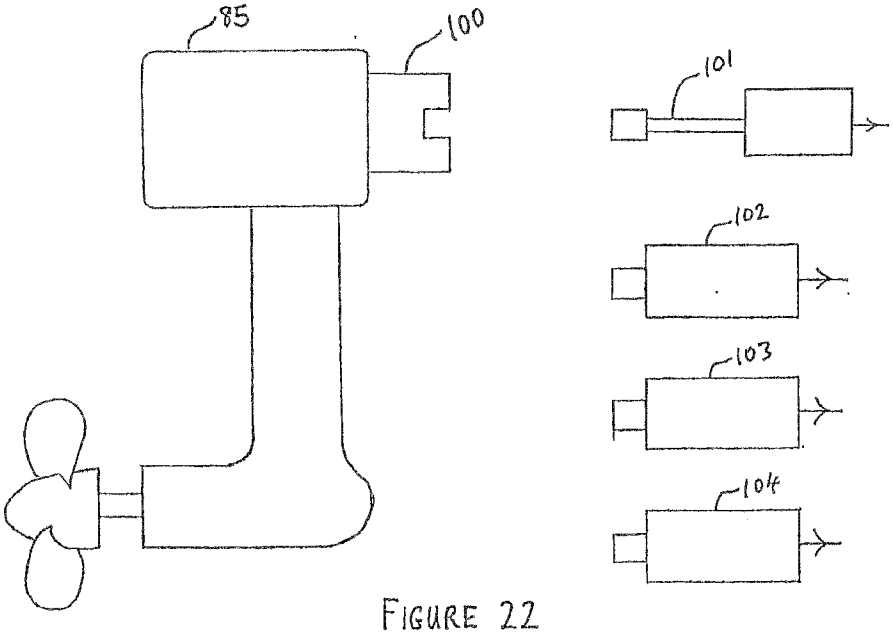


FIGURE 22

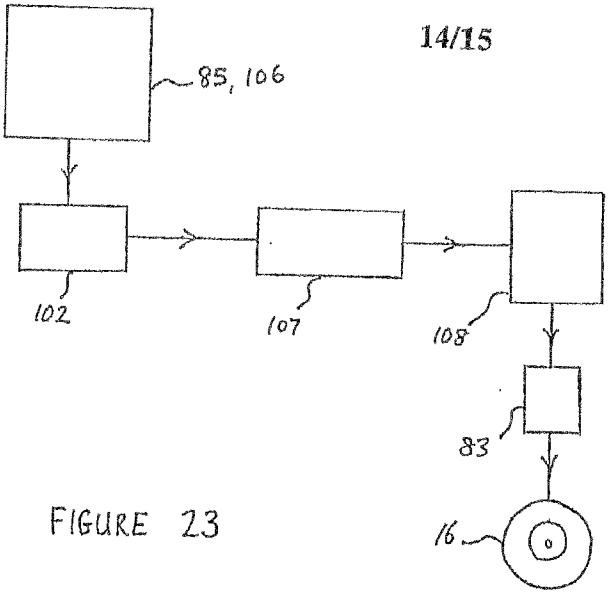


FIGURE 23

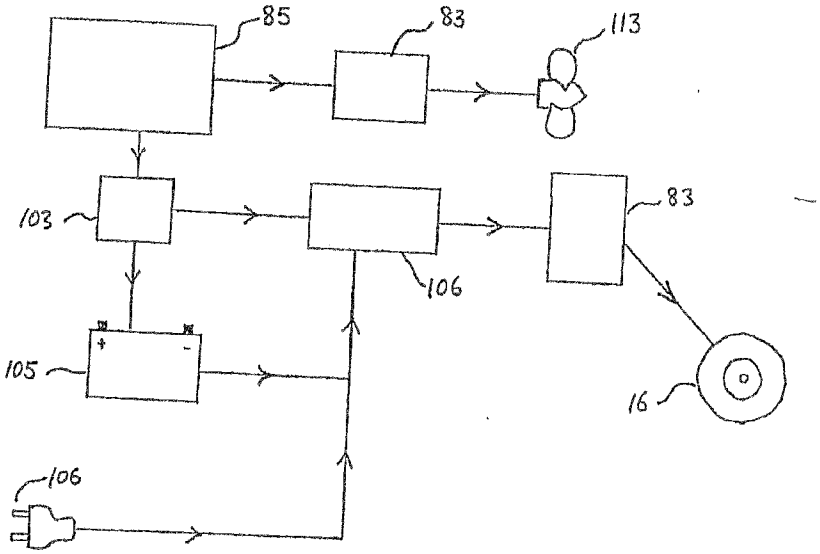


FIGURE 24

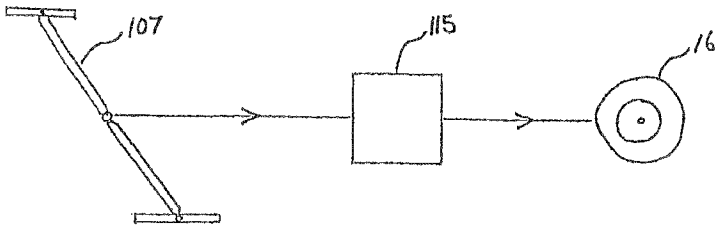


FIGURE 25

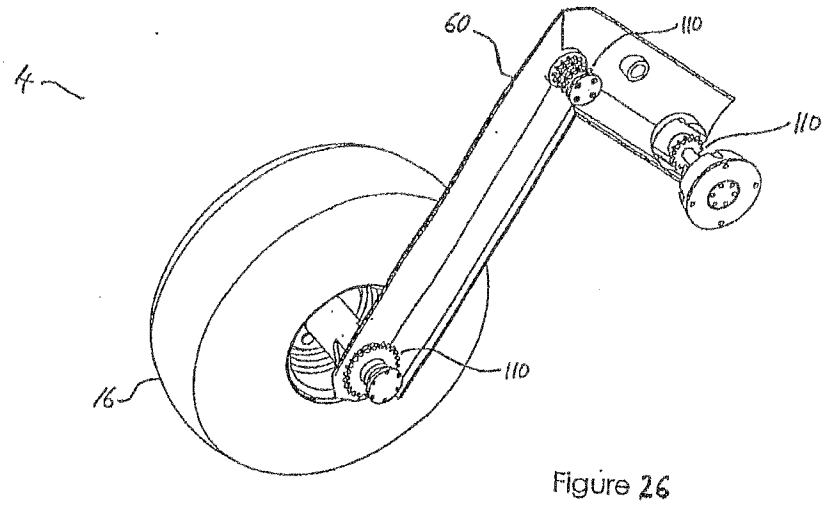


Figure 26

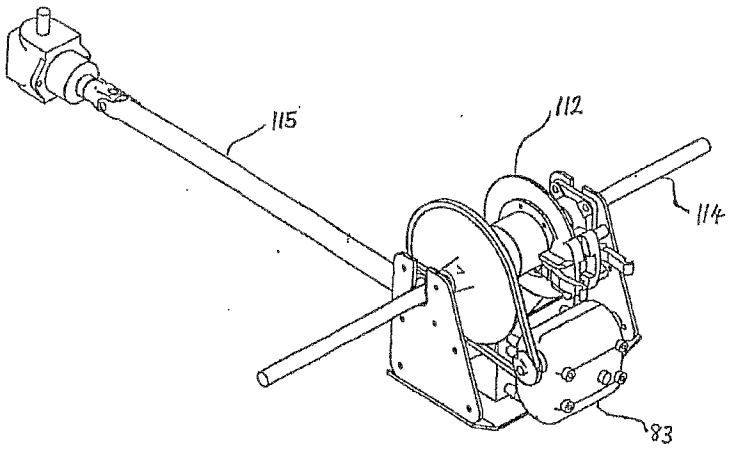


Figure 27